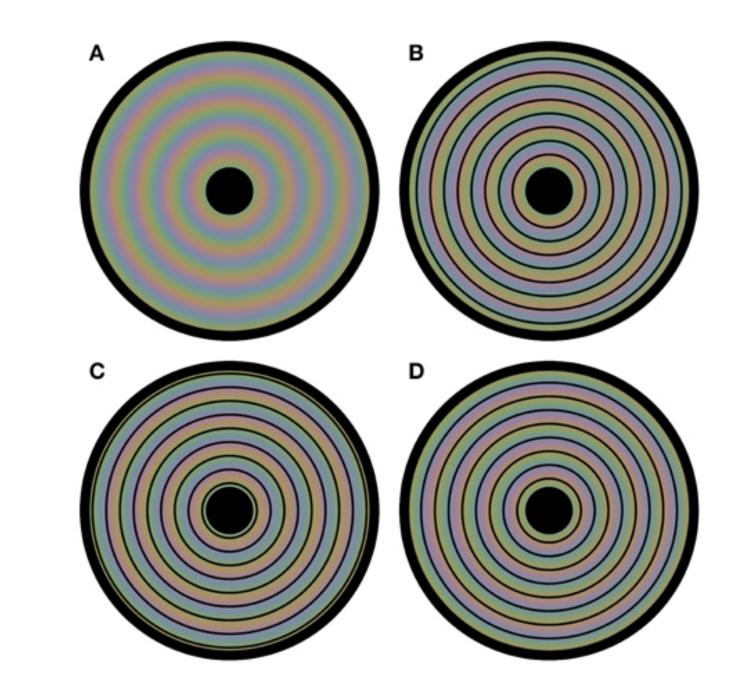# Biologically-Inspired Log-Polar Boundary Extraction Model for Noisy Colored Images

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Contour-Color Relationship

Color is an attribute of shape

Color perception depends on boundary placements

Figure adapted from Fig. 1 from Vergeer et al. (2015). (A) Base stimulus without boundary. (B-D) Different placements of boundaries on the same stimulus in (A) produce different perceptions of color.
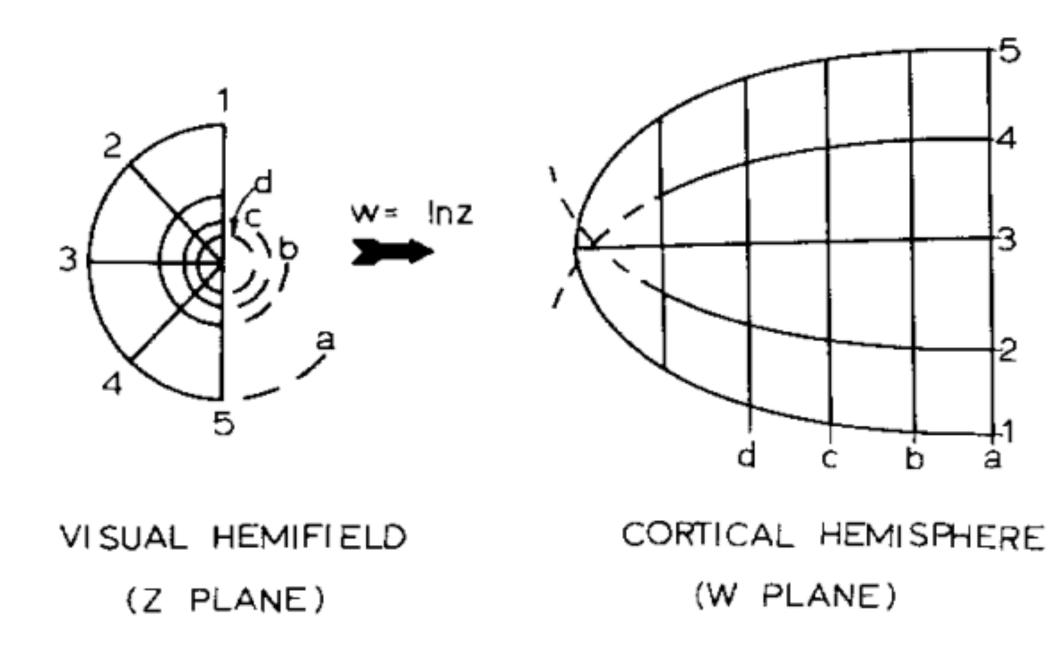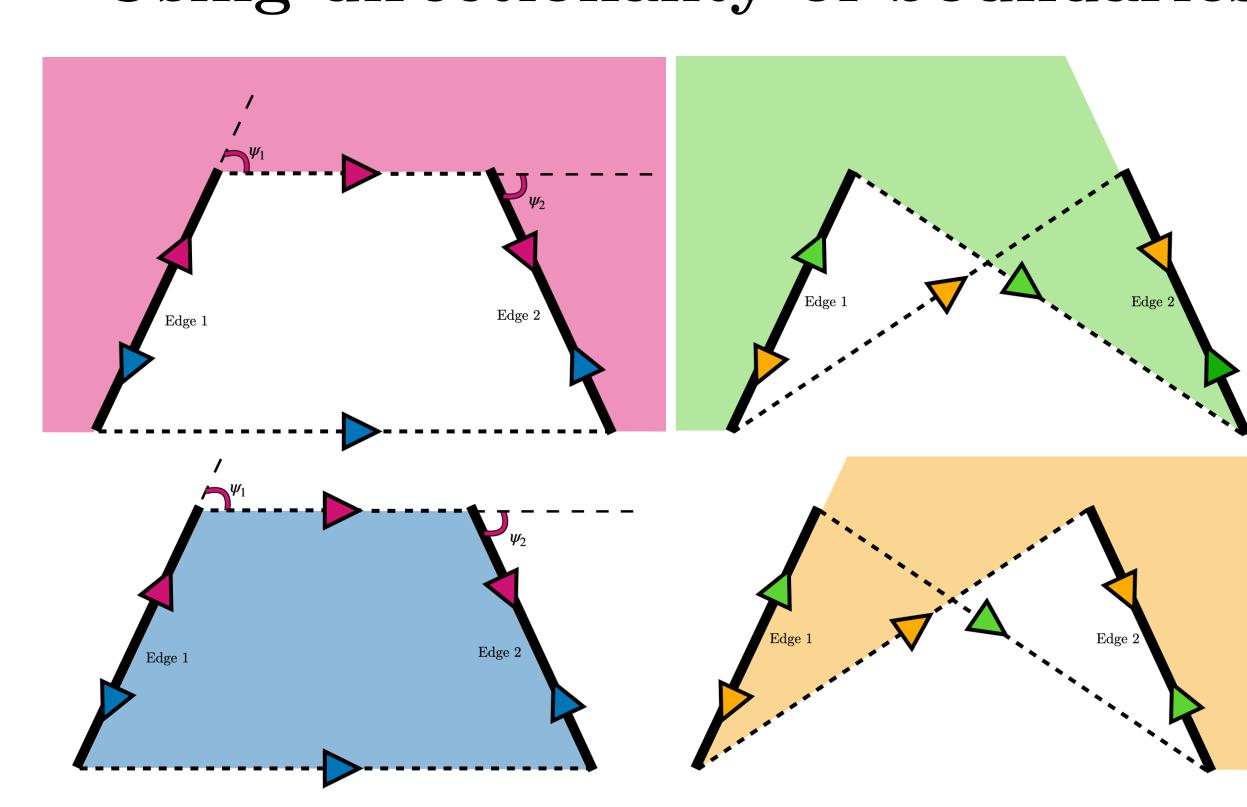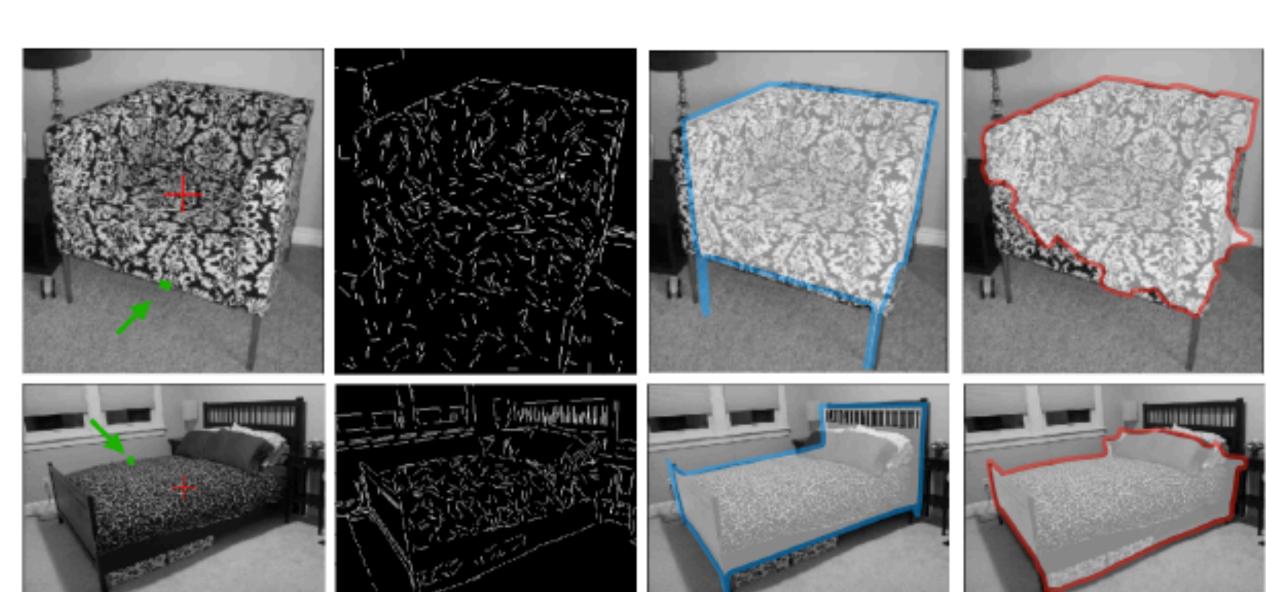
Contour (Edges)

Log-polar representation

Figure adapted from Fig. 1. C from Schwartz, E. L. (1977). Log-polar retinotopic mapping.

Color (Region)

Interior / Exterior Regions
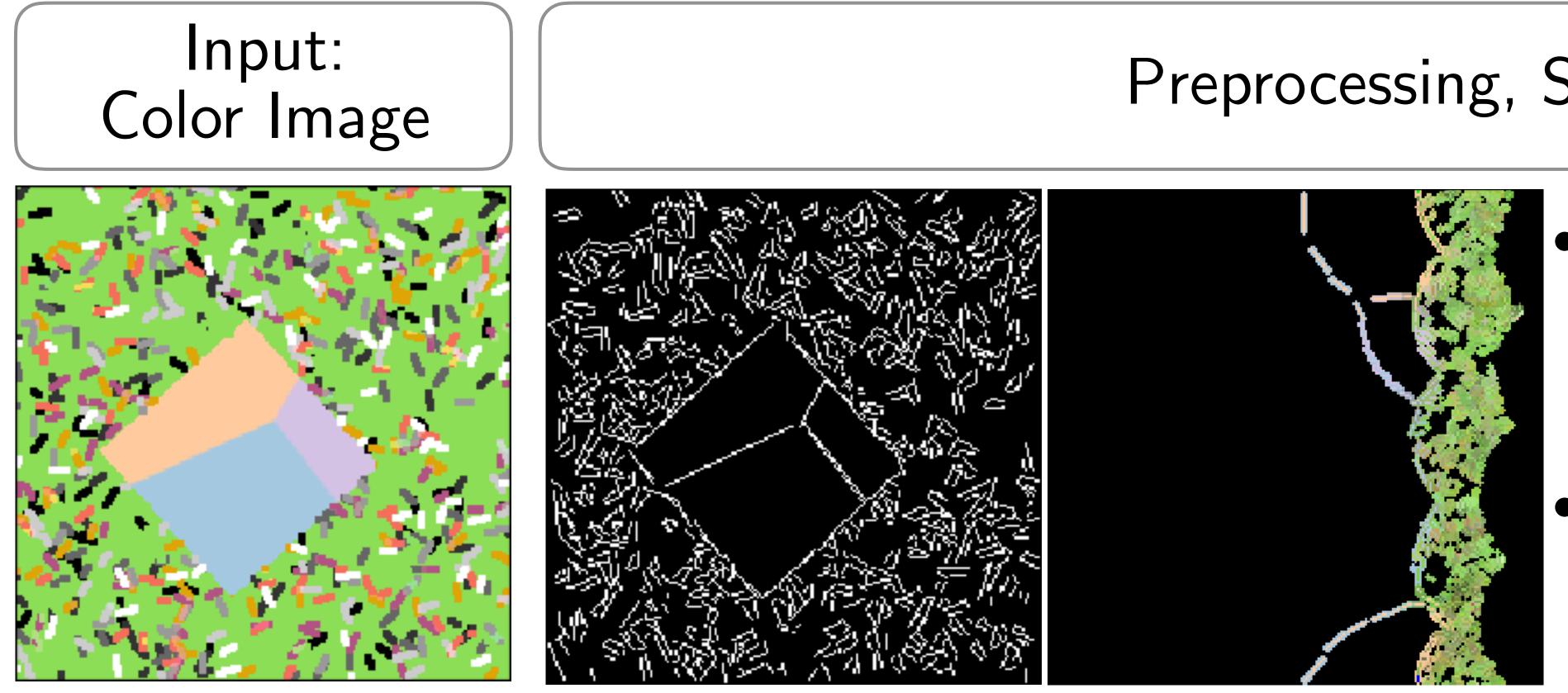Using directionality of boundaries

Contour-Only Model Results

Contour-Only model successfully extracted furnitures

Contour-only model tested on Pix3D dataset. (i) Grayscale image. (ii) Extracted Edges. (iii) Ground truth. (iv) Contour-only model result.

The Model: Contour + Color

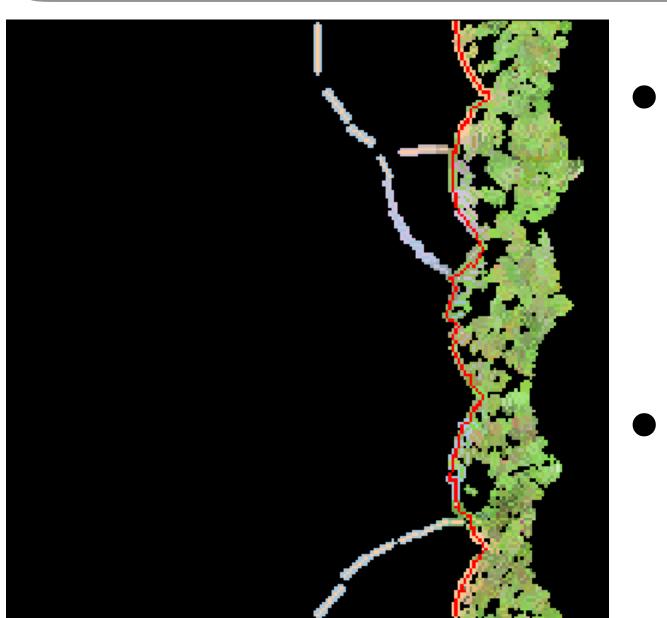| Input: Color Image	Preprocessing, Setup Graph	Global Optimization	Output

- Preprocessing: Edge detection, color extraction, log-polar transformation
- Fully-connected graph with direction: 4 ways to permute between 2 edges
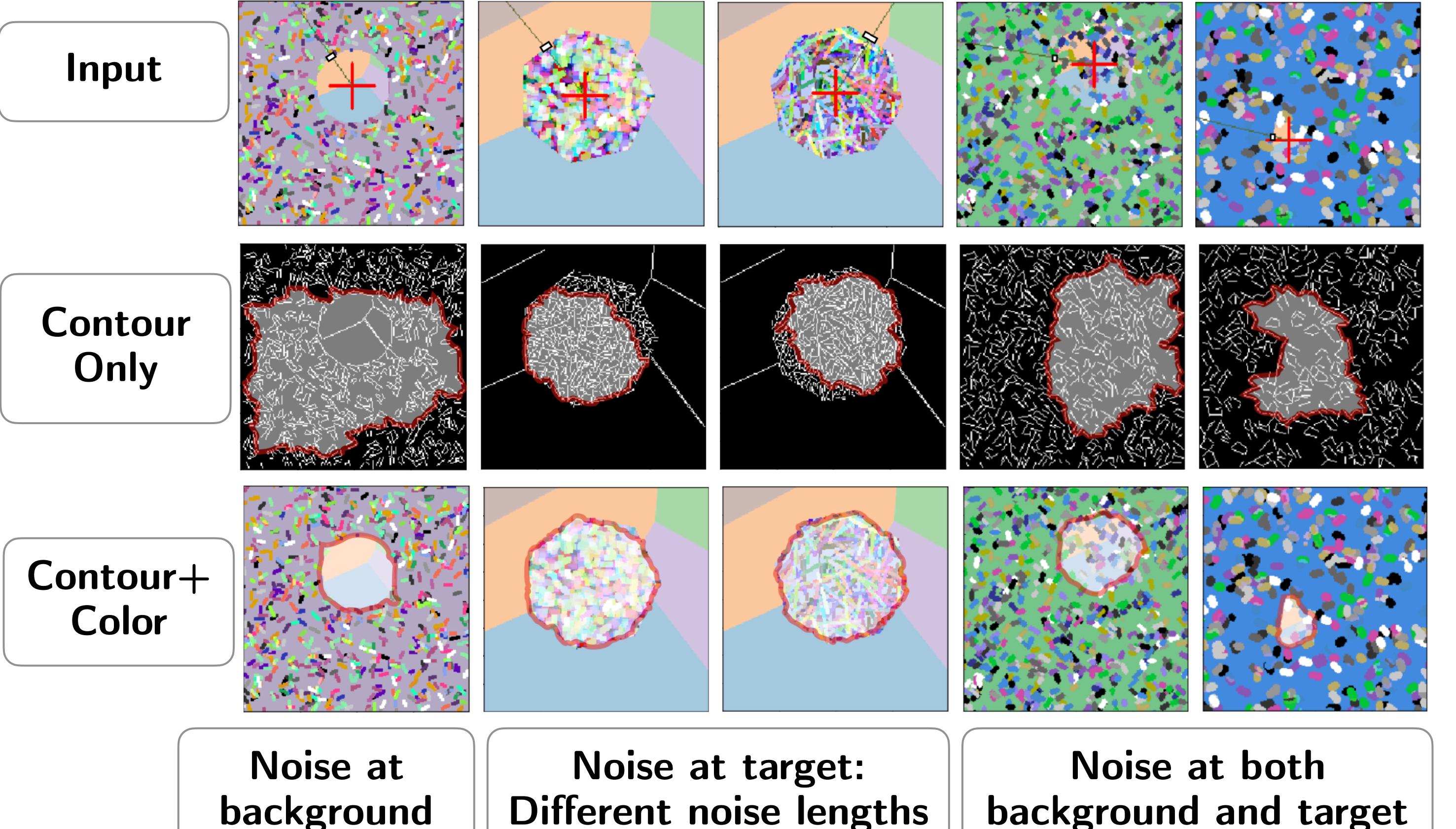
- Dijkstra shortest path between duplicated representations (0, 2π rad.)
- 3-parameter cost function: Distance, interpolation angle, color dissimilarity

Results: Contour-Only vs Contour + Color

Input

Contour Only

Contour+ Color

Noise at background	Noise at target: Different noise lengths	Noise at both background and target

Conclusions

Conclusion 1 — Contour + color model was robust to different manipulations of noise

Conclusion 2 — Color was analyzed as regional information: optimizing for consistent color at region interior or exterior to the target shape

Conclusion 3 — No bias for small- or big-sized shapes: Target boundaries were extracted regardless if noise was in the background or inside the target

References

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Kwon, T., Agrawal, K., Li, Y., & Pizlo, Z. (2016). Spatially-global integration of closed, fragmented contours by finding the shortest-path in a log-polar representation. *Vision research*, 126, 143-163.

Schwartz, E. L. (1977). Spatial mapping in the primate sensory projection: analytic structure and relevance to perception. *Biological cybernetics*, 25 (4), 181–194.

Vergeer, M., Anstis, S., & van Lier, R. (2015). Flexible color perception depending on the shape and positioning of achromatic contours. *Frontiers in Psychology*, 6 , 620.